Fuel Cells Provide Reliable Power to U.S. Postal Service Facility in Anchorage, Alaska

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ABSTRACT

Working together, the U.S. Postal Service (USPS) and Chugach Electric Association, partnering with the Department of Defense (DOD), Department of Energy (DOE), US Army Corps of Engineers Construction Engineering Research Laboratories (USA CERL), Electric Power Research Institute (EPRI), and National Rural Electric Cooperative Association (NRECA), developed and installed one of the largest fuel cell installations in the world.

The 1-Megawatt fuel cell combined heat and power plant sits behind the Anchorage U.S. Postal Service Mail Processing and Distribution Facility. Chugach Electric owns, operates, and maintains the fuel cell power plant, which provides clean, reliable power to the USPS facility. In addition, heat recovered from the fuel cells, in the form of hot water, is used to heat the USPS Mail Processing and Distribution Facility. By taking a leadership role, the USPS will save over $800,000 in electricity and natural gas costs over the 5 1/2-year contract term with Chugach Electric.

> "Fuel cells solved a handful of problems.," Cathe Grosshandler, Alaska District Environmental Coordinator, U.S. Postal Service

BACKGROUND

The U.S. Postal Service Mail Processing and Distribution Facility, adjacent to the Anchorage International Airport, serves as the postal hub

*Operated for the U.S. Department of Energy by Battelle Memorial Institute under contract DE-AC06-76RL01830.

for all of Alaska, see Figure 1. The facility processes, on average, over one million pieces of mail every day, operating 24 hours per day, 365 days per year. Annual energy costs for the 270,000-square-foot facility exceeded $300,000 for electricity and $35,000 for natural gas.

The facility faced a series of issues that needed to be addressed. To meet new environmental codes, the facility needed to upgrade an existing underground fuel oil tank serving the facility's 600-kW emergency generator. As a result of an expansion to the facility and adding new optical mail processing equipment, the facility's peak electric demand had grown larger than the existing emergency generator could support. Upgrades were also needed to the UPS (uninterruptible power supply). In addition, the two 80-horsepower boilers (2,700,000 Btu/h), which heat the facility, also needed some improvements.

Rather than solving each issue separately, the District Environmental Coordinator wanted a comprehensive solution. The answer seemed to lie in a highly reliable, highly efficient combined heat and power plant.

PROJECT SUMMARY

Initially, a combined heat and power plant using natural gas engine generators was proposed. However, after attending a local energy technology show, the USPS began to consider fuel cells. By coincidence Chugach Electric Association, the serving electric utility, was developing expertise in fuel cell technology and supported the USPS interest in the emerging technology.

Fuel cells produce electricity through an electrochemical reaction rather than combustion. While more expensive than conventional power generating equipment, fuel cells provide efficient, reliable power with minimal emissions. (For more information on fuel cells, see FEMP's Federal Technology Alert, "Natural Gas Fuel Cells," at http://www.eren.doe.gov/femp/prodtech/fed_techalert.html.)

To increase overall reliability, the combined heat and power plant consists of five fuel cells with room for a future sixth unit. Thus, the system can meet the facility's peak 800-kW demand even when one fuel cell is off-line. The resulting 1-Megawatt (1,000-kW) combined heat and power plant consists of five fuel cells, a nitrogen tank, heat recovery equipment, a pump house, and the site management system (SMS), see Figure 2.

Figure 1. The Mail Processing and Distribution Facility, adjacent to the Anchorage International Airport, is key to the Alaska mail system.

Figure 2. Set against the Chugach Mountains, five fuel cells supply reliable and clean power to the USPS facility.

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The fuel cells, manufactured by International Fuel Cells, Inc. (formerly ONSI), are rated at 200 kW each and are fueled by natural gas. Nitrogen is used to purge the fuel cells during startup and shutdown cycles. The pump house is used to move the heat generated by the fuel cells to either the facility for space heating or to the cooling modules, where the excess heat is rejected.

What makes the system a success is the site management system (SMS). The SMS includes fuel cell load control, grid interconnection, and a high-speed switching system. The SMS allows the multiple fuel cell system to transfer between grid-parallel and grid-independent in under 4 milliseconds (1/4 cycle in a 60-Hz system), fast enough that the transfer does not interrupt the highly sensitive computer systems in the USPS facility. Normally, the fuel cells operate in parallel with the Chugach electric grid. Excess power generated by the fuel cells flows out into the Chugach grid. However, in the case of a grid outage, the SMS identifies the outage, isolates the USPS facility from the grid and allows the fuel cells to transfer to grid-independent mode seamlessly. The SMS was developed under this project but is now commercially available and being specified for use in other fuel cell power systems.

The entire project cost $5.5 million, including the research and development for the SMS. Funding for the project came from the many partners involved in the effort. What made the project work economical for the U.S. Postal Service is a special contract between the USPS and Chugach Electric. Chugach Electric owns, remotely operates, and maintains the fuel cell power plant, which is located on the USPS property. The only cost to the USPS was the $1 million up-front cost as part of a 5 1/2-year contract for baseline electrical service. In return, Chugach Electric provides baseline electricity to the mail processing facility for the 5 1/2-year term at no additional cost. If electricity requirements at the USPS facility grow above the set baseline, which the USPS believes is unlikely, additional electricity is purchased at standard rates.

In addition, the USPS facility owns the use of the heat recovered from the fuel cells. Heat energy from the fuel cells is available in the form of hot water at two temperatures: 240°F and 140°F. At this time, the higher temperature water is used for heating the facility. The lower temperature heat is rejected through the cooling modules.

BENEFITS

The fuel cell combined heat and power (CHP) plant provides a number of benefits to the USPS. The most significant benefit has been the increased reliability of electric service. Restarting the mail processing equipment after a power outage requires a significant level of effort. The increased reliability results in fewer power outages, thereby avoiding unscheduled shutdowns and restarts. The fuel cell and SMS have worked flawlessly since commissioned. In fact, the week before Christmas, on one of the busiest days of the year, construction at the airport caused a local power outage. The entire area was without power for over 4 hours. All, except the U.S. Postal Service, that is. The SMS system automatically switched the facility to operate grid-independent with no interruption. The USPS facility went on to set records, processing over 1.4 million letters and parcels that day, while the neighbors were sitting in the dark.

While the combined heat and power project does not reduce electricity consumption at the USPS facility, it does significantly reduce USPS energy costs. The contract between the USPS and Chugach Electric provides baseline electrical service to the USPS facility for 5 1/2 years at a cost of $1 million. Previously, electricity for the USPS facility averaged over $300,000 per year.

Heat recovered from the fuel cells is being used for space heating in the mail processing facility, thereby displacing the load on the original boiler heating system, see Figure 3. In fact, savings have exceeded the original estimate. Initially, it was determined that the fuel cell heat energy could meet around 50% of the total facility space heating needs. During the first year of operation, the heat recovered from the fuel cells has satisfied all the space heating needs. Although the winter of 2000-2001 was milder than average, heat recovered from the fuel cells has exceeded expectations.

Some capital cost reductions were also achieved. The demonstrated reliability of the fuel cell and site management system has eliminated the need to upgrade the existing emergency generator. However, the old 1000-gallon, single-wall, below-grade fuel oil tank still needed to be replaced. A new dual-wall, 500-gallon, above-ground fuel oil tank was determined to be sufficient because of the increased reliability of the new power supply system. In addition to the cost reduction from the less expensive, smaller tank, the environmental code features were also less expensive for the smaller tank size. Avoiding the need to upgrade the

Figure 3. Heat recovered from the fuel cells offsets heat supplied by the boiler system. The boilers were not needed during the winter of 2000-2001.

emergency generator and installing a smaller fuel oil tank saved the USPS an estimated $500,000 in capital costs.

LESSONS LEARNED

The USPS recommends that any site thinking about a similar project should consider the following:

- Projects of this nature require "champions." Each of the parties involved in the project recognized the value of local champions who could think outside the box, overcome barriers, and push the project through.
- Consult with the local utility, DOE regional office, and other organizations to investigate potential partnerships. Both the USPS and

Chugach Electric Association believe a more effective solution was achieved as a result of the partnership.

- Take a holistic approach to solving facility needs. The USPS had to address a series of issues. Although each facility need could have been solved individually, the fuel cell combined heat and power plant solved several of the needs simultaneously and at a lower cost.

Being the largest fuel cell installation of its time made this a distinctive installation. However, it will not remain unique. The development of the SMS will lead to more multi-unit fuel cell power plants with high-speed reliability.

LOOKING AHEAD

The USPS facility is looking for additional uses for the heat recovered from the fuel cells. While the high temperature heat recovered is perfect for space heating, there is still significant heat energy available at 140°F, which has yet to be utilized. The USPS is still investigating several potential uses for this valuable heat energy.

The SMS has additional capabilities that the USPS may use in the future. In addition to controlling fuel cell operation, the SMS is also capable of controlling peak electrical demand through load shedding. This feature could be used to prevent overloading the power plant when the electric grid is down and the fuel cells are operating independent of the electric grid. The ability to load shed while operating grid-independent could prevent a shutdown of the fuel cell power plant as a result of an overload condition.

At the end of the contract period, the USPS and Chugach Electric will renegotiate the future of the fuel cell combined heat and power plant. No one knows what the future may bring, but all agree the project has been a success.

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